Reason in the Roasting of Eggs

“Reason in the roasting of eggs”

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In the 18th century egg-roasting was a sufficiently puzzling activity that it inspired a familiar saying, “There is reason in the roasting of eggs.” The aphorism was intended to justify the most arcane of activities, but actually the reason for roasting eggs has been unknown until recently. In this essay I claim that there is indeed a good nutritional explanation for this now vanished culinary tradition, as there is for cooking any other food: cooked food gives us more energy than we would get by eating the same food raw. I then use this realization to advance a further proposal: our consumption of cooked food makes possible not just our high energy budgets, but also the extreme size of our brains. Accordingly the notion of “reason in the roasting of eggs” includes a second meaning beyond the assertion of mere utility. It encapsulates my claim that the evolution of human mental powers has depended on our ancestors’ food being cooked.

No such thought was in Edmund Burke’s mind in 1773 when a dinner party conversation prompted him to reflect on the significance of cooking. He was responding to the idea that human beings can be defined as the species that cooks. James Boswell, diarist and amanuensis of lexicographer Samuel Johnson, made the proposal and recorded the conversation.

Boswell began by rejecting previous definitions of humanity. “An ancient philosopher said,” he declared, “(that) Man was ‘a two-legged animal without feathers,’ upon which his rival Sage had a Cock plucked bare, and set him down in the school before all the disciples, as a ‘Philosophick Man.’ Dr. Franklin said, Man was ‘a tool-making animal,’ which is very well; for no animal makes a thing, by means of which he can make another thing. But this applies to very few of the species.”

He continued with his own proposal. “My definition of Man is, a ‘Cooking Animal’. The beasts have memory, judgement, and all the faculties and passions of our mind, in a certain degree; but no beast is a cook. … Man alone can dress a good dish; and every man whatever is more or less a cook, in seasoning what he himself eats.”

Burke approved Boswell’s idea. “Your definition is quite good,” he said, “and I now see the full force of the common proverb, ‘There is reason in the roasting of eggs.’”

Burke may have thought he saw the full force of the proverb, but what he meant when he quoted it can only have been the idea that humans cook for a reason. As for what the reason was, Burke surely did not know because until the last two decades no one had systematically investigated why we cook. Conventional wisdom acknowledged that cooking could remove poisons, kill bacteria and enormously improve the taste and texture of an evening meal, but there was no consensus as to whether cooking was necessary or what was its most important function. As late as the 1960s, when the anthropologist Claude Lévi-Strauss proposed that people cook merely to symbolize their distinction from animals, no one is recorded as objecting to his stated assumption that cooking was an arbitrary choice. To Lévi-Strauss and most of anthropology, humans were no different from other animals, equally capable of a successful life-style whether or not our food was cooked.

Fortunately “raw-foodism” has become popular recently, so this habit of restricting diet to raw foods has created new opportunities for investigation. Results are consistent.. On the one hand, people can eat 100% of their food raw and be healthy enough for an active life. Indeed, many raw-foodists keep to their diets because they feel very good on them. Yet unlike non-humans, human raw-foodists are so relatively short of energy that not only do they lose weight on average, but their bodily functions are also liable to be impaired. In the only research on the reproductive performance of women, conducted by a survey of several hundred Germans, the average woman on a 100% raw diet had too few spare calories to be able to menstruate. The study indicated that whether or not their diets included meat, and even when eating domesticated foods taken from the global food resource (and therefore free of a seasonal drop in food quality), women could not reproduce effectively when eating raw. Domesticated foods are much more effective sources of energy than wild foods, and our ancestors expended much more energy as hunter-gatherers than raw-foodists do in urban environments. So while a raw diet of domesticated foods can sustain people in the West today, a long-term raw diet of wild foods, of the type that our ancestors ate before 10000 years ago, would be impossible. In short, although humans are animals, we are different from other animals. Without domesticated foods and an urban lifestyle, we need cooked food (Wrangham 2009).

A close look at our intestinal systems shows one of the reasons. Our intestines are small compared to those of other primates. An excellent advantage of guts being small is that they cost less to run than the more elaborate digestive structures of our raw-food-eating ancestors. However a species can afford for their guts to be small only if they can predictably obtain a diet that is easily digested. In the case of human ancestors, cooked food explains our diminutive digestive adaptations, from our small mouth and teeth to our absent caecum and greatly reduced colon. We can get away with the reduced size of these structures because cooked food is easier to digest than raw food. Thus like other comparisons between cooked and raw foods, a baked potato takes a shorter time to digest than a raw potato. It demands less muscular churning, acid secretion, enzyme production and other biological investment. Furthermore, a baked potato also provides us with more of its digestible energy than a raw potato.

The fact that cooked food provides more energy than raw food is the main reason our lineage can afford to forego efficient digestion of raw food. The fundamental logic for the extra energy is that cooking involves heat. Because hotter molecules move faster, their structure changes. They tend to open up in ways that allow component chains to be more easily attacked by enzymes. Starches gelatinize, changing a previously semi-crystalline structure into a solution of glucose-rich strings. Proteins denature, exposing otherwise hidden threads of amino-acids. Fats melt, releasing lipids from inert solidity. Animal species do not need special adaptations to take advantage of these benefits from cooking. Most animals prefer cooked food, and they fare so well on a cooked diet that many of our pets now have an obesity problem. But human ancestors were the only species that made the breakthrough to preparing cooked food on a daily basis, which allowed them to follow the unique path of becoming committed to eating it. The skill of cooking thus gave us more calories per gram of food, not to mention a wider range of foods that we could exploit. The enhanced energy we obtain by using external fuel to improve our food is a main reason why we are now the dominant species on earth.

Life is in many ways a search for energy, so a species that achieves a new level of energy acquisition faces expanded biological opportunities. Perhaps none was more important than the chance to invest in the brain.

Human brains have two very odd features. They are relatively enormous, and they been increasing in size rather steadily for a long time (more than two million years).

Their structure and neurophysiology, by comparison, are less obviously odd. Indeed, to a large extent the size of brain regions is predicted by the size of the whole brain. This does not mean that we have the same brain proportions as smaller-brained species. For example the percentage of our brain volume that is devoted to neocortex is higher than in smaller-brained species. However the extent of this disproportion is itself predicted by our brain volume, because among other primates, those with larger brains likewise devote a higher proportion to neocortex than those with smaller brains. Within a group of closely related animals such as humans and great apes, overall brain volume is thus an excellent predictor of brain structure.

Brain size is also a good predictor of intelligence. Species of primates can be ranked according to their general cognitive ability by assessing their performances on a range of cognitive tests. Across species general cognitive ability is well correlated with total brain size. For example the correlation is stronger than it is with measures of relative brain size such as those that control for differences in body size (Deaner et al 2007). Such studies use average brain volumes for the species, measured in dead animals. Non-invasive measuring techniques also allow investigators to measure brain volumes in living individuals. They show that within species too, variation in brain size is related to intelligence. Rats with bigger brains solve cognitive tasks better. Humans with bigger brains have higher ‘g’ (general intelligence), more fluid ability and greater memory, though not greater crystallized ability. Correlations between brain size and cognitive ability in these studies of rats and humans are in the range of 0.3 to 0.5 (Wickett 2000).

A good starting-point for explaining the evolution of uniquely human intelligence, therefore, is to account for the large size of our brains. The difficulty in doing so is that brains are exceptionally expensive. Their energetic running costs average some 8-10 times higher than those of skeletal muscle, and unlike a computer, brains can never be turned off. The more that brains are used, the more energy they consume. For example when subjects are asked to exert self-control in thinking, their body glucose levels measurably drop (Gailliot et al 2007). Overall human brains consume more than 20% of the energy used by the body at rest, far more than their weight would suggest. So the problem of explaining the evolution of human brain size becomes a problem of understanding how brains are powered. Where do we get the extra energy needed to fuel our big brains?

In theory a species like humans that has a hungry brain and access to sufficient food might be able to increase its resting metabolic rate (the number of calories used per unit time to power the body when at rest) so as to divert extra calories to the brain. In actuality, however, this solution does not occur. Metabolic rate has been well measured in humans and related primates. Remarkably, in relation to body weight the resting human metabolic rate is exactly as expected for a typical primate. The discovery that we do not simply run our metabolism at a high overall rate is highly enlightening. It means that the only way for humans to devote disproportionate amounts of glucose to fuelling our large brain is to give relatively less energy to some other parts of the body.

Leslie Aiello and Peter Wheeler were the first to realize the significance of the unchanged human metabolic rate. They showed that most of the energy-hungry organs, such as liver, kidney and heart, have the same relative size and energy needs in the human body as in non-human primates. The only organ system that stood out by being relatively reduced in size in humans was the gut. Aiello and Wheeler found the human gut to be relatively small, including stomach, small intestine, caecum and colon, and they noted that its maintenance is energetically expensive. Their finding suggested that variation among species in the size of the gut might offer opportunities for the evolution of large brains (Aiello and Wheeler 1995).

In line with their hypothesis, primate species with smaller guts indeed tend to have bigger brains. The obvious explanation for their small guts is that they have an especially high-quality diet, affording them the luxury of a reduced digested capacity.. This proves correct. Primates that eat more animal matter and calorie-dense plants in the wild have especially high quality diets, and are found to have bigger brains than other primates (Leonard et al 2003). Aiello and Wheeler also calculated the energetic savings for humans of having smaller guts than expected. The savings neatly match the extra energy needed because our brains are large.

These results combine into a simple and striking formula. Cooking is responsible for our small guts; and the small size of our guts allows us to power an increasingly large brain. So cooking gave us a bigger brain and higher intelligence that we could otherwise have managed.

The fact that the quality of the human diet is uniquely high fits satisfactorily with the human brain being uniquely large, but a diet of cooked food is not the only potential solution to the energy puzzle. Aiello and Wheeler themselves gave as much attention to meat as to cooking. When the brains of our presumed ancestors started growing beyond the ape size, between two and three million years ago, their possessors were beginning to cut meat from the bones of prey animals but they had certainly not become committed to cooking. So Aiello and Wheeler suggested that meat-eating was likely responsible for the initial rise in brain size, on the basis that meat-eating carnivores such as cats and dogs tend to have small guts. Their suggestion about cooking was that it could account for a later rise in brain size, around half a million years ago, when the evolution of *Homo erectus* into *Homo heidelbergensis* was marked by a notable increase in cranial capacity (from around 1000 to 1200 cubic centimeters). My own interpretation of the evidence is that *Homo erectus* was already adapted to cooked food by about 1.9 million years ago, because only cooking provides a ready explanation for the characteristically small guts and teeth found in *Homo erectus*. Furthermore there is no later time in human evolution when any subsequent reduction of the gut is recorded. My attribution of cooking as early as 1.9 million years ago is controversial however, because although it fits with the biological inference, direct archaeological evidence of the use of fire is inconsistent earlier than 400,000 years ago. So the conservative conclusion is that cooking began its contribution to the steady rise in human brain size sometime between 1.9 million and 400,000 years ago.

Whenever cooking was developed, however, its impact on reducing the costs of digestion surely had a substantial effect on brain enlargement. The largest known brain of any ape or fossil pre-human that was definitely confined to raw food (*Australopithecus/Homo habilis*) was merely half the volume of our more than 1400 cubic centimeters. If humans became adapted to cooked food as improbably late as 400,000 years ago, the result was to add only 200 cc of brain volume. More likely, on the assumption that cooking began with *Homo erectus*, brains roughly doubled in size under the influence of cooked food.

The impact of cooking did not have to stop there. While the first oddity of the human brain is its relatively large size, the second is the way it achieved this outlier status. Our ancestors have exhibited a near-continuous rise in brain size for more than two million years, eventually leading to a trebling of volume. During the same period other animals, by comparison, had no change in brain volume or a much more modest increase. Since the benefits of elevated intelligence must have been particularly high in increasingly complex social groups, some have argued for a positive feedback loop: large brains enabled larger groups, which then intensified the advantages of being more intelligent. But while that kind of idea might explain the advantages of increasing cognitive ability, it misses the critical point that however strong the selection pressure in favor of large brains, and whatever benefit intelligence gave, the problem of the energetic constraint must also be solved. Unless our ancestors had higher metabolic rates than we do, which no evidence suggests, they had to fuel their brains from somewhere within their bodies.

In this context cooking offers interesting possibilities for the long continued rise in brain size. The techniques of the first cooks were doubtless limited to placing roots, seeds or meat by a fire so as to roast it. Recent hunter-gatherers were still practicing those simple techniques in the last two centuries, but they also employed a variety of more complex skills. The earth oven was a technique that kept cooked food moist and even hinted of cuisine, because it allowed herbs to be added to the food. Earth ovens are evidenced from at least two hundred thousand years ago, and were probably worldwide. Varieties of sausage were made in several places. Pots and containers could be used from plants such as bamboo, or from inverted turtle shells. Accumulated advances in cooking skill would have made food not only more palatable but also easier to digest. A more easily digested meal, in turn, would demand less energy from the gut, and spare more for other organs such as the brain.

There are other factors that may have contributed to solving the brain-energy crisis too. Species of birds with smaller breast muscles have bigger brains, indicating that energetically efficient locomotion can spare energy for the brain (Isler and van Schaik 2006). Travel is energetically cheaper in humans than in chimpanzees, and likely became so when our ancestors stopped regularly climbing trees almost two million years ago. Terrestrial adaptations of the human body might thus have saved further energy that could be diverted to the brain.

So cooking was not necessarily the only route to a larger brain, but its impact was very large. The adoption of cooked food as a staple part of the diet gave our ancestors increased energy, enabled them to reduce the size of important components of their guts, and therefore most likely enabled those with bigger brains to survive and flourish. Nowadays hunter-gatherers who collect eggs return to camp with them when possible, and roast them by burying them in hot ashes. The practice is one of many with a deep history that revolutionized our ancestors' energy metabolism and paved the way for a larger brain and higher intelligence. When Edmund Burke quipped that there was reason in the roasting of eggs he spoke a truer word than he could have imagined. We can rewrite Descartes. I cook, therefore I think. Coquo, ergo cogito.

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